WHAT IS CLAIMED IS:

1. An apparatus which performs a plasma process on a target substrate by using plasma, comprising:

an airtight process chamber which accommodates the target substrate;

a gas supply system which supplies a process gas into the process chamber;

an exhaust system which exhausts an interior of the process chamber and sets the interior of the process chamber to a vacuum state;

first and second electrodes arranged in the process chamber to oppose each other, an RF field, which turns the process gas into plasma by excitation, being formed between the first and second electrodes;

an RF power supply which is connected to the first or second electrode through a matching circuit and which supplies RF power, the matching circuit serving to automatically perform input impedance matching relative to the RF power;

an impedance setting section which is connected, through an interconnection, to a predetermined member to be electrically coupled with the plasma in the plasma process, and which sets a backward-direction impedance as an impedance against an RF component input from the plasma to the predetermined member, the impedance setting section being capable of changing a value of the backward-direction impedance; and

a controller which supplies a control signal concerning a preset value of the backward-direction impedance to the impedance setting section.

2. The apparatus according to claim 1, wherein the controller further comprises a storage which stores data concerning a correlation between first and second processes having different conditions and first and second preset values, corresponding to the first and second processes, of the backward-direction impedance, and the controller supplies to the impedance setting section a control signal which changes the backward-direction impedance from the first preset value to the second preset value on the basis of the data when a process to be performed in the process chambers changes from the first process to the second process.

3. The apparatus according to claim 1, wherein the preset value is set in advance such that a planar uniformity of the plasma process on the target substrate is improved.

4. The apparatus according to claim 1, wherein the preset value is set in advance such that the plasma stabilizes.

5. The apparatus according to claim 1, wherein the plasma processing apparatus is an etching apparatus, the target substrate has a mask layer having a pattern and a lower layer to be etched which is under the mask layer, and the preset value is so set in

advance as to control a size to be processed of the lower layer.

6. The apparatus according to claim 1, wherein the impedance setting section comprises one or both of an arrangement which continuously changes the backward-direction impedance with a continuous variable element, and an arrangement which changes the backward-direction impedance stepwise by switching a plurality of fixed elements.

7. The apparatus according to claim 1, wherein the impedance setting section comprises a function which displays the preset value.

8. The apparatus according to claim 1, wherein the controller or the impedance setting section corrects the preset value with calibration data that compensates for a difference intrinsic to the impedance setting section, and then adjusts the backward-direction impedance.

9. The apparatus according to claim 1, wherein the RF power supply is connected to the first electrode through a first interconnection, the impedance setting section is connected to the second electrode through a second interconnection, and the RF component includes a fundamental frequency of the RF power.

10. The apparatus according to claim 1, wherein the RF power supply and the impedance setting section are connected to the first electrode through a first

interconnection, and the RF component includes a harmonic of a fundamental frequency of the RF power.

11. The apparatus according to claim 10, wherein the value of the input impedance is so set by the impedance setting section as to be not less than twice a value of an RF load impedance formed by the process chamber and the plasma against the RF power.

12. An apparatus which performs a plasma process on a target substrate by using plasma, comprising:

an airtight process chamber which accommodates the target substrate;

a gas supply system which supplies a process gas into the process chamber;

an exhaust system which exhausts an interior of the process chamber and sets the interior of the process chamber to a vacuum state;

first and second electrodes arranged in the process chamber to oppose each other, an RF field, which turns the process gas into plasma by excitation, being formed between the first and second electrodes;

an RF power supply which is connected to the first or second electrode through a matching circuit and which supplies RF power, the matching circuit serving to automatically perform input impedance matching relative to the RF power;

an impedance setting section which is connected, through an interconnection, to a predetermined member

to be electrically coupled with the plasma in the plasma process, and which sets a backward-direction impedance as an impedance against one of a plurality of different higher harmonics relative to a fundamental frequency of the RF power input from the plasma to the predetermined member, the impedance setting section being capable of changing a value of the backward-direction impedance; and

a controller which supplies a control signal concerning a preset value of the backward-direction impedance to the impedance setting section.

13. The apparatus according to claim 12, wherein the predetermined member is selected from the first and second electrodes and the process chamber.

14. The apparatus according to claim 12, wherein the predetermined member comprises a focus ring disposed to surround the target substrate.

15. The apparatus according to claim 12, wherein the predetermined member comprises a rectifying plate disposed between a process space in the process chamber and an exhaust path.

16. The apparatus according to claim 12, wherein the impedance setting section comprises one or both of an arrangement which continuously changes the backward-direction impedance with a continuous variable element over the plurality of different higher harmonics, and an arrangement which changes the backward-direction

impedance stepwise by switching a plurality of fixed elements.

17. The apparatus according to claim 12, wherein the impedance setting section has a filter to select a higher harmonic as a resonance target.

18. The apparatus according to claim 17, wherein the filter has a high impedance of not less than 50Ω against harmonics other than a selected harmonic.

19. The apparatus according to claim 17, wherein the filter comprises a filter selected from the group consisting of a high-pass filter, bandpass filter, low-pass filter, and notch filter.

20. The apparatus according to claim 17, wherein the filter cuts a component having the fundamental frequency of the RF power.

21. An apparatus which performs a plasma process on a target substrate by using plasma, comprising:

an airtight process chamber which accommodates the target substrate;

a gas supply system which supplies a process gas into the process chamber;

an exhaust system which exhausts an interior of the process chamber and sets the interior of the process chamber to a vacuum state;

first and second electrodes arranged in the process chamber to oppose each other, an RF field, which turns the process gas into plasma by excitation,

being formed between the first and second electrodes;

first and second interconnections which are respectively connected to the first and second electrodes and which extend to an outside of the process chamber, the first and second interconnections forming part of an AC circuit including electrical coupling between the first and second electrodes;

a first RF power supply which is arranged on the first interconnection and which supplies first RF power;

a first matching circuit which is arranged on the first interconnection between the first electrode and the first RF power supply and which automatically performs input impedance matching relative to the first RF power;

an impedance setting section which is arranged on the second intersection and which sets a backward-direction impedance as an impedance against an RF component input from the plasma to the second electrode, the impedance setting section being capable of changing a value of the backward-direction impedance, and the RF component including a component having a fundamental frequency of the first RF power; and

a controller which supplies a control signal concerning a preset value of the backward-direction impedance to the impedance setting section.

22. The apparatus according to claim 21, wherein the second interconnection is grounded through the impedance setting section.

23. The apparatus according to claim 21, further comprising:

a second RF power supply which is arranged on the second interconnection and which supplies second RF power; and

a second matching circuit which is arranged on the second interconnection between the second electrode and the second RF power supply and which automatically performs input impedance matching relative to the second RF power.

24. The apparatus according to claim 23, wherein the first RF power has a frequency higher than that of the second RF power.

25. The apparatus according to claim 23, wherein the first RF power has a frequency lower than that of the second RF power.

26. An apparatus which performs a plasma process on a target substrate by using plasma, comprising:

an airtight process chamber which accommodates the target substrate;

a gas supply system which supplies a process gas into the process chamber;

an exhaust system which exhausts an interior of the process chamber and sets the interior of the

process chamber to a vacuum state;

first and second electrodes arranged in the process chamber to oppose each other, an RF field, which turns the process gas into plasma by excitation, being formed between the first and second electrodes;

first and second interconnections which are respectively connected to the first and second electrodes and which extend to an outside of the process chamber, the first and second interconnections forming part of an AC circuit including electrical coupling between the first and second electrodes;

a first RF power supply which is arranged on the first interconnection and which supplies first RF power;

a first matching circuit which is arranged on the first interconnection between the first electrode and the first RF power supply and which automatically performs input impedance matching relative to the first RF power;

an impedance setting section which is arranged on the first intersection and which sets a backward-direction impedance as an impedance against an RF component input from the plasma to the first electrode, the impedance setting section being capable of changing a value of the backward-direction impedance, and the RF component including a harmonic of a fundamental frequency of the first RF power; and

a controller which supplies a control signal concerning a preset value of the backward-direction impedance to the impedance setting section.

27. The apparatus according to claim 26, wherein a value of the input impedance is so set by the impedance setting section as to be not less than twice a value of an RF load impedance formed by the process chamber and the plasma against the first RF power.

28. The apparatus according to claim 26, further comprising:

a second RF power supply which is arranged on the second interconnection and which supplies second RF power; and

a second matching circuit which is arranged on the second interconnection between the second electrode and the second RF power supply and which automatically performs input impedance matching relative to the second RF power.

29. The apparatus according to claim 28, wherein the first RF power has a frequency higher than that of the second RF power.

30. The apparatus according to claim 29, wherein the first RF power has a frequency lower than that of the second RF power.

31. An apparatus which performs a plasma process on a target substrate by using plasma, comprising:

an airtight process chamber which accommodates

the target substrate;

a gas supply system which supplies a process gas into the process chamber;

an exhaust system which exhausts an interior of the process chamber and sets the interior of the process chamber to a vacuum state;

first and second electrodes arranged in the process chamber to oppose each other, an RF field, which turns the process gas into plasma by excitation, being formed between the first and second electrodes;

first and second interconnections which are respectively connected to the first and second electrodes and which extend to an outside of the process chamber, the first and second interconnections forming part of an AC circuit including electrical coupling between the first and second electrodes;

a first RF power supply which is arranged on the first interconnection and which supplies first RF power;

a first matching circuit which is arranged on the first interconnection between the first electrode and the first RF power supply and which automatically performs input impedance matching relative to the first RF power;

an impedance setting section which is arranged on the first intersection and which sets a backward-direction impedance as an impedance against an RF

component input to the first electrode;

a second RF power supply which is arranged on the second interconnection and which supplies second RF power, the second RF power supply being capable of changing a frequency of the second RF power;

a second matching circuit which is arranged on the second interconnection between the second electrode and the second RF power supply and which automatically performs input impedance matching relative to the second RF power; and

a controller which supplies a control signal concerning a preset value of a frequency of the second RF power to the second RF power supply.

32. The apparatus according to claim 31, wherein the impedance setting section has the backward-direction impedance which is a constant preset value.

33. The apparatus according to claim 31, wherein the impedance preset unit comprises one or both of an arrangement which continuously changes the backward-direction impedance with a continuous variable element, and an arrangement which changes the backward-direction impedance stepwise by switching a plurality of fixed elements.

34. A calibration method for the impedance setting section in the apparatus according to claim 1, the method comprising steps of:

obtaining, by measurement, calibration data that

compensates for a difference in setting the backward-direction impedance which is intrinsic to the impedance setting section; and

adjusting the preset value with the calibration data and then adjusting the backward-direction impedance.

35. The method according to claim 34, further comprising steps of:

obtaining, with a reactance measurement unit, a correlation between the preset value and a reactance of the impedance setting section against the RF component; and

obtaining the calibration data on the basis of a predetermined reference correlation and the obtained correlation.

36. The method according to claim 35, wherein the impedance setting section is connected to the first electrode, and the RF component has a frequency of the RF power to be applied to the second electrode, or a frequency that largely influences a distribution of the plasma.

37. The method according to claim 35, wherein the reactance measurement unit is connected to an output terminal of the impedance setting section.

38. The method according to claim 35, wherein the impedance setting section is connected to the first electrode in the apparatus, and the reactance

measurement unit is connected to the first electrode in the method.

39. The method according to claim 34, wherein

the impedance setting section is connected to the first electrode in the apparatus, and

the method comprises steps of

obtaining a correlation between a first parameter and the preset value, the first parameter representing information selected from the group consisting of a voltage amplitude of an RF power applied to the first electrode, an adjustment value of a matching circuit connected to the first electrode, a voltage amplitude of an RF power applied to the second electrode, an adjustment value of a matching circuit connected to the second electrode, and an output from an end point detection spectroscope, and

obtaining the calibration data on the basis of a predetermined reference correlation and the obtained correlation.

40. The method according to claim 39, wherein the controller automatically changes the backward-direction impedance of the impedance setting section, so that data concerning a change in the first parameter is acquired, thus obtaining the calibration data.